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A Rationale for Technical Guidelines on Predictive Locational Modeling of Archaeological Resources on U.S. Army Installations

James A. Zeidler

Introduction

This technical note provides an overview of the objectives and rationale for the development of Department of the Army (DA) guidelines for predictive archaeological modeling in support of the Integrated Cultural Resource Management Plan (ICRMP), which is now required at all Army installations. The note includes a brief discussion of:

- the utility of GIS-based predictive modeling for cultural resource compliance planning and risk assessment,
- the complexity of the data requirements and analytical procedures involved, and
- the need for installation cultural resource managers to have a basic understanding of the modeling process.

Managers need this information in order to acquire predictive models (either through in-house development or out-of-house contracting) and to use the results in daily decision-making. These technical guidelines are currently under development as an applied research effort of the Cultural Resources Research Center (CRRC) of the U.S. Army Construction

Engineering Research Laboratories
(USACERL).

Background

Current Department of Defense (DoD) and U.S. Army guidance on cultural resource management on military installations recommends that installation resource managers develop predictive locational models of prehistoric and historic archaeological sites in support of their ICRMP. Guidance for developing the ICRMP is provided in DoD Instruction 4715.3, Army Regulation 200-4, and DA Pamphlet 200-4. Predictive archaeological modeling falls under the rubric of the "planning level survey" for archaeological resources. During the planning level survey, the known archaeological resources on the installation are assessed and their density and location are projected onto unsurveyed areas to help cultural resource managers in planning. Typically, these projections are expressed in probabilistic terms and are displayed visually in a Geographic Information System (GIS)

environment. DoD Instruction 4715.3 (p12) states: "the cultural resources inventory of archeological resources should include, at a minimum, the analysis, identification, and prioritization of all potential archeological locations on the installation and verification of the presence or absence of archeological resources in all areas that might be adversely impacted by military activities." Thus the planning of future archaeological inventory surveys and site assessments should be predicated on knowledge of where pertinent resources are likely to be found, as well as on the degree to which they might be impacted by military training and other land use activities.

Compliance with historic preservation legislation governing archaeological resources presents a number of difficulties for military installations. Installations typically have large landholdings, the majority of which has yet to be surveyed for the purpose of identifying and assessing archaeological resources. Managing these unsurveyed lands and planning for future compliance becomes a guessing game in which little or no information is available to help make sound and justifiable decisions regarding land clearance or resource protection. The fiscal and manpower requirements for complying with existing historic preservation legislation are especially burdensome for installations with large military training efforts.

Today, only 30 percent of military lands have been surveyed for archaeological resources. Current survey strategies are often inefficient, do not incorporate three-dimensional search procedures, and do not prioritize study areas based on the likelihood of finding or not finding archaeological sites. For the large tracts of unsurveyed lands, no reliable basis exists for evaluating potential impacts to resources from military training exercises and other land use activities. As the

authors of the 1994 Andrulis Report on user requirements of the U.S. Army Conservation Pillar noted, "...[T]he need exists to improve the effectiveness of pedestrian survey for archaeological sites. Lessons learned during the past ten years suggest that predictive models based on geomorphological data can improve the efficiency of archaeological surveys. The development of such models would allow the bypassing of land where the chances of finding cultural resources are low, allowing concentration of scarce resources on areas of high probability."

The ability to identify probable areas of archaeological resource occurrence during the planning stages of military training and construction projects would provide cultural resource specialists with a powerful management tool. Not only would it allow for more efficient planning and timely execution of the archaeological inventory survey process, it would also provide crucial information needed to justify the avoidance of intensive land use practices such as military training on archaeologically sensitive areas. When faced with large tracts of unsurveyed lands, however, installation resource managers often have no way of prioritizing the landscape in terms of either the likelihood of finding archaeological resources or the likelihood that those resources will be impacted by military training and other land-use activities.

A sound predictive model together with a geomorphological assessment of local landscape dynamics can provide the installation resource manager with a powerful GIS-based decision support framework for both immediate and long-range management decisions regarding archaeological resources. Benefits of a modeling/assessment process include more efficient and cost-effective archaeological survey planning and execution, enhanced training readiness (by reducing the

likelihood of unanticipated archaeological discoveries and by flagging potentially adverse impacts), and enhanced compliance capabilities and long-term stewardship.

Rationale for Predictive Models

The use of predictive locational modeling in archaeology has a considerable history extending back to the early 1980s; the literature on this topic is now extensive and complex. Many kinds of predictive modeling can be used in archaeology. A given model's accuracy and degree of sophistication vary according to:

- (1) the nature and complexity of the archaeological record in a given study area,
- (2) the nature and reliability of the existing archaeological survey data upon which the model is developed,
- (3) the availability and reliability of suitable GIS-based data layers of the environmental variables used for the modeling exercise (see Figure 1),
- (4) the availability of suitable computer hardware and GIS software for spatial data display and multivariate statistical analysis, and
- (5) the analytical knowledge and predisposition of the modeler in developing the predictive modeling design and in the successful execution of the modeling effort.

These factors all contribute to the variability of predictive archaeological models. At each step in the development process a series of decisions must be made regarding the archaeological (dependent) variables and the environmental (independent) variables to use and on the most appropriate statistical procedures to use given the nature of the data sets. Data requirements are of crucial importance in determining what kind of modeling effort (i.e., its degree of accuracy and sophistication) will be feasible in a given case. Once a predictive model has been

developed, it is also important to consider its validity before actually using it for compliance decisions. Validation usually involves formal procedures in which the initial model is tested through independently derived site distribution data, and is either validated or refined.

From the perspective of the cultural resource manager at a given military installation, there are numerous predictive models that could be used as an "off-the-shelf" template or guide for developing a model for the installation landscape. Previous modeling efforts may exist for the region or for the installation itself; these can be used productively to build a better model since many of the archaeological and environmental variables would presumably be the same. However, the enormity of the data gathering tasks and the analytical complexity required by such modeling efforts places a big burden on the installation cultural resource specialist managing a wide range of other compliance-driven tasks. As a consequence, in-house predictive models are rarely carried out and even when they are contracted out to the private sector, they often result in products of uneven quality, mixed expectations in terms of their ultimate utility for management and planning, and suboptimal expenditure of Army funds.

Accordingly, the Department of the Army has dedicated applied research funds to address this problem and develop technical guidelines on the data requirements and "best scientific practices" for developing reliable predictive models of archaeological resources on Army installations, especially those with intensive training missions. In cases where model development is contracted out-of-house, it is imperative that the installation cultural resource specialist have a fundamental understanding of predictive modeling in order to be able to develop

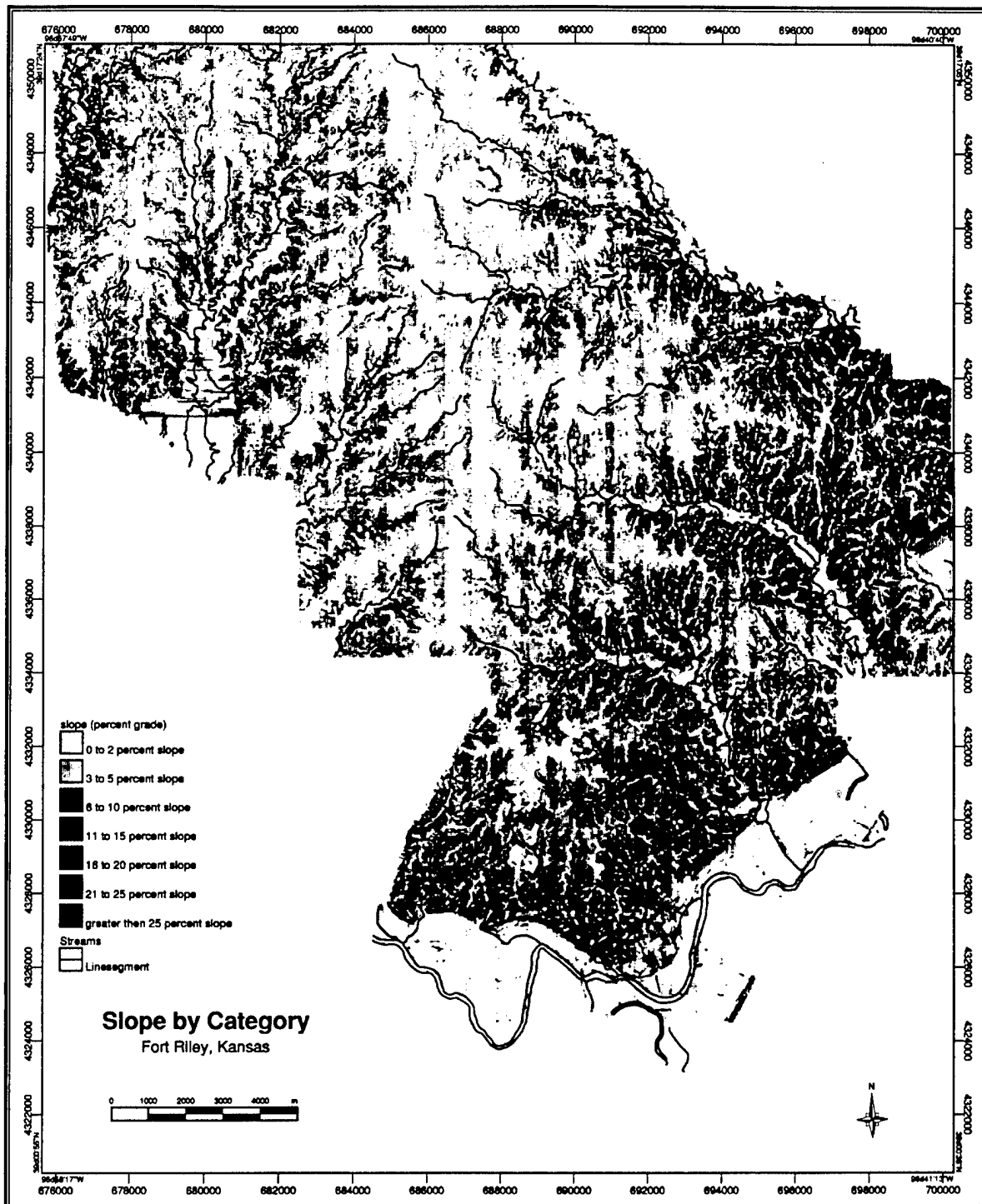


Figure 1. GIS data layer for Surface Slope expressed in percentage grade intervals. This map represents an important environmental variable to be used in a predictive archaeological modeling effort for Fort Riley, KS.

adequate scopes-of-work, evaluate the quality and reliability of final products, and ensure that expectations of the modeling effort are fully met for purposes of resource management and compliance.

The purposes of this CRRC/USACERL applied research project are to:

- (1) provide a timely capability to deal with the significant deficiency in planning-level surveys,

- (2) provide guidance regarding how to evaluate the options available for modeling and validation, and select the most appropriate approach (in terms of required data inputs, expected outcomes, and validation procedures) for a given case, and capture the best understanding of the successful modeling work from the scientific/academic community,

- (3) translate and synthesize the scientific/academic options into a step-by-step approach for installation managers, including sample scopes-of-work for contracting such modeling efforts, and

- (4) provide guidance on how predictive models can be effectively integrated into the installation ICRMP for purposes of risk assessment and compliance planning.

It is important to emphasize that no single cookbook approach to predictive archaeological modeling is advocated. The project is aimed at providing the installation resource manager with a flexible framework for (1) understanding the data requirements and analytical complexity of predictive locational modeling so he or she is prepared to contract out-of-house expertise for a modeling effort and (2) evaluating the modeling results both in terms of its methodological rigor and its ultimate utility for compliance planning and decision support.

Products

The product of this 2-year research effort will be a protocol document that will provide installation resource managers with:

- (1) general guidelines on data requirements and various technical options for developing, or for contracting out (including a draft statement of work), an archaeological predictive model in a GIS environment,

- (2) technical guidance on how the final model can be most effectively implemented in an installation-wide decision support system,

- (3) a discussion of two predictive modeling case studies from major Army installations located in different ecoregions of the United States (Fort Riley, KS, and Fort Bliss' McGregor Range, NM), and

- (4) a comprehensive bibliography on predictive archaeological modeling. The resulting document is scheduled to be made available during the second quarter of Fiscal Year 1999 and will be distributed to the cultural resource management community throughout the Department of Defense and other Federal landholding agencies.

Summary

The purpose of the work unit on predictive archaeological modeling is to provide the Army's cultural resource management community with technical guidelines on the data requirements and methodological options for constructing GIS-based predictive models. The resulting document will provide an explicit rationale for such modeling efforts in the context of

comprehensive planning level surveys required by the installation's ICRMP. Installation cultural resource managers should be aware of both the utility and the complexity of these models so that they can base local model expectations on a firm understanding of how such models are developed and validated.

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